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Final Technical Report
Covering the Period January 1, 1986 - March 31, 1993

NASA-Ames Grant #NCC 2-342

OPTIMIZATION OF KNOWLEDGE-BASED SYSTEMS AND EXPERT SYSTEM BUILDING TOOLS

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FINAL TECHNICAL REPORT

NASA-AMES COOPERATIVE AGREEMENT NO. NCC 2-342

OPTIMIZATION OF KNOWLEDGE-BASED SYSTEMS AND EXPERT SYSTEM BUILDING TOOLS

For the period January 1, 1986–March 31, 1993

The objectives of the NASA-AMES Cooperative Agreement No. NCC 2-342 were to investigate, develop, and evaluate, via test cases, the system parameters and processing algorithms that constrain the overall performance of the Information Sciences Division's Artificial Intelligence Research Facility. Written reports covering various aspects of the grant have been submitted to the co-investigators for the grant, Dr. Henry Lum from 1986–1990 and Donald McKellar from 1991 to the present date.

Research studies have concentrated on the field of artificial intelligence knowledge-based systems technology. Activities have included the following areas:

1. AI training classes.
2. Merging optical and digital processing.
3. Science experiment remote coaching.
4. SSF Data Management System tests.
5. Computer Integrated Documentation Project.
6. Conservation of Design Knowledge Project.
7. Project Management Calendar and Reporting System.
8. Automation and robotics technology assessment.
9. Advanced computer architectures and operating systems.
10. Honors program.

The following paragraphs expand on each of these areas.

1. AI TRAINING CLASSES

In 1986, a training class of AI technologies was presented to Agency personnel. In 1987, two training courses were developed and delivered: "An Introduction to ADA" and "Advanced Topics in Common LISP".

2. MERGING OPTICAL AND DIGITAL PROCESSING

In 1986, research succeeded in interfacing an optical processor to the ISD's VAX 11/780 computer. In 1987, a MassComp 5600 computer was successfully interfaced to a Lyton Optical Light Modulator.

3. SCIENCE EXPERIMENT REMOTE COACHING

From 1990–1992 we played a major role in the operation of the Remote Coaching Laboratory and assisted in design, implementation, and research into the effects of video compression. Consultation services on experimental design and data analysis related to multimedia telecommunications were provided related to the Space Station Freedom Program.

4. SSF DATA MANAGEMENT SYSTEM TESTS

In 1991 we calculated the fixed-point instruction throughput of the embedded processor for the Data Management System (DMS) for the Space Shuttle Freedom using an instruction mix specified in the DMS Contract-End-Item specification; initial results indicated that the 4.0 MIPS throughput requirement will not be met. Work was begun on testbed development for the FDDI network. Software fixes for the Network Test Procedure Executive (NTPE) program were completed. NTPE allows a user to create multiple test plans which can be executed on multiple computers. Evaluation of Graphical User Interface (GUI) builder tools was begun based upon the X-Window system graphics display protocol.

5. COMPUTER INTEGRATED DOCUMENTATION PROJECT

In 1991 and 1992 work was done on Computer Integrated Documentation Project whose goal was to build an integrated documentation and improve information and knowledge retrieval during operations. XCMD's (external command) and XFCN's (external functions), software resources written in C language on the Macintosh for the functioning of CID, were developed in 1991. Features necessary for contextual knowledge acquisition were implemented using hypertext media and methods were developed for specific text processing and representation in the hypertext format for Space Station Freedom documents.

6. CONSERVATION OF DESIGN KNOWLEDGE PROJECT

In 1986 and 1987, we continued research into the capture of systems design data in a form that could be used by humans and by automated decision-making and advising systems.

From 1988–1990 we functioned as the NASA technical project leader in collaboration with Stanford University in the Conservation of Design Knowledge project. The project attempted to capture the reasoning behind the design of a system. The information was to be stored and represented in such a way that it could be used to enhance the management of a system, both during design and throughout the system's whole life cycle. The project investigated the possibility of providing the designer with an electronic notebook. Within the framework of this notebook, a Design Rationale Inferencer, which attempts to automatically capture the rationale for the designer's decisions was investigated. This project resulted in a publication entitled "Conservation of Design Knowledge".

7. PROJECT MANAGEMENT CALENDAR AND REPORTING SYSTEM (PMCRS)

We completed the design and prototyping of the Project Management Calendar and Reporting System (PMCRS) which allows project managers to plan, schedule,

control, analyze, and report on their projects. It was implemented on a small scale during 1990 but was found to be lacking in versatility.

8. AUTOMATION AND ROBOTICS TECHNOLOGY ASSESSMENT

Detailed technical reviews and assessments of automation and robotics technology were conducted in support of Space Station Freedom. Five ATAC Progress Reports were prepared from 1990-1992. Technical input was provided to assist in the initiation of an Information Sciences Division Aeronautics Program Plan. Final versions of the Information Sciences Division Strategic Plan were prepared and published.

9. ADVANCED COMPUTER ARCHITECTURES AND OPERATING SYSTEMS

In 1986, planning began for the development of a test system that would simulate and do fault diagnosis on a mechanical system.

In 1988, we helped develop parallel constructs for parallel processing and translated LISP benchmarks into ADA.

In 1989–90 we accomplished our goals and objectives in support of the Space borne VISICH Multiprocessor System (SVMS) project, developed a configuration of benchmarks to test specific computer architecture, and developed, designed, and analyzed the parallel concept of the LISP version of AutoClass II.

10. HONORS PROGRAM

The Honors program successfully placed a dozen students in positions where they could work under the direction of NASA research scientists on various research projects.

PUBLICATIONS

Internal and external publications partially or fully created through the efforts of grant personnel included:

Conservation of Design Knowledge, 1989.
Introduction to the IMV or "Space Sub" (voiceover script), 1990.
ATAC Progress Reports 11–15, 1990–1992.
"The Effects of Video Compression on Acceptability of Images for Monitoring Life Sciences Experiments," NASA Technical Paper 3239, 1992.
"Interactive Displays for Trajectory Planning and Proximity Operations," *Journal of Spacecraft and Rockets*, 1992.
"A Study of Video Frame Rate on the Perception of Moving Imagery Detail, *NASA TM*, 1992.
Night Flying, TAB Books/McGraw-Hill, New York, 1992

PRINCIPAL INVESTIGATORS

The Principal Investigators for Foothill DeAnza Community College were Vivian Frederick (1986-1991) and Phyllis Yasuda (1991-1992). Co-Investigators for NASA-Ames were Henry Lum (1986-1990) and Don McKellar (1991-1992).